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The Straw Dot moth *Rivula sericealis* (Scop.) (Lep.: Noctuidae): how many broods?

The observation by Brian West (*Ent. Rec.* **115**: 286-287) that the Straw Dot *Rivula sericealis* is regularly double-brooded, and occasionally triple-brooded, in his garden on the outskirts of south-east London, prompted me to look more closely at my own data on this species. Though there were similarities between our two gardens, there were also differences. The opportunity was taken, therefore, to examine the situation in closer detail.

A preliminary examination of the literature suggests that existing data on voltinism in this species is sparse and inconclusive and does not allow any real decision to be made concerning whether there are two broods of adults or one protracted brood. For Britain, Barrett (1900. *The Lepidoptera of the British Islands*) states simply that the moth is on the wing from the end of June to the end of August. More recently, Bretherton, Goater & Lorimer, writing in volume 10 of *Moths and Butterflies of Great Britain and Ireland* (Harley Books, 1983) observed that "*It is not possible to state the number of generations with any certainty, as the moth may be seen in any month from late May to early October; much probably depends on the early summer rainfall and consequent succulence of the foodplant after midsummer; so that hibernated larvae complete their growth at varying speeds in different years. The resulting emergence is spread throughout June and July and there is at least one more complete generation, possibly even a partial third in southern England.*" The possibility exists that both the phenology (the period when it is an adult) and the voltinism (number of generations per year) may be affected by latitude and so a quick examination of the European literature is also of interest and relevance.

For Northern Europe, Skou (1991. *Nordens Ugler*) writes "*In Denmark and southern Sweden from mid June to mid September, probably in two continuous generations. Further to the north only one generation from late June to mid August.* I am most grateful to Peder Skou for e-mailing me a translation of his text for this species. It may be worth bearing in mind that in terms of latitude, Denmark and southern Sweden extend approximately from Newcastle-upon-Tyne to Orkney. For France, Culot (1915. *Noctuelles et Géomètres d'Europe*, volume 2) notes the adult from May to September, making no comment on voltinism; later French texts do not appear to give flight periods. For Central Europe, Nowacki (1998. *The Noctuids of Central Europe*) reports positively "*May to September in two generations*". For the

Czech and Slovak Republics, Bělín (2003. Noční motýli České a Slovenské republiky) records adults from May to July and August to October, implying two broods but not specifying. Further south, in Romania, Rákosy (1996. *Die Noctuiden Rumäniens*) notes adults from May to July and August to mid-September with, if I have translated the German correctly, a peak ("*Flugmaximum*") from mid August to mid September. Further south still into Bulgaria, and my good friend Dr Stoyan Beshkov tells me that all of his records fall in the period from the 23 May to 23 September. He states that "*For Bulgaria* R. sericealis *is not an interesting species, it is widely distributed everywhere in low altitude. I have continuously collected it, as freshly emerged specimens of both males and females, from May, June, July, August and September. In the old literature (Buresch & Tuleschkow, 1935) it is reported in two generation – May-June and August-September. My opinion now is, that it has probably at least three generations, but I can not prove this.*" I should add that I have not, myself, examined the work by Buresch & Tuleschkow which is, in any case, printed in Cyrillic text which I do not understand. Finally, in Greece, Hacker (1989. *Die Noctuiden Griechenlands*) states that the moth apparently flies from April to September in two or three generations; it is not clear if he means the number varies or if he is not certain which number applies.

Data sets obtained from a single site are probably too small to permit a proper analysis, even if the trap was run on every night. Far better to look at records from a larger number of sites, though constraining the overall area studied to eliminate significant variation in geography, climate, altitude or other factors. Accordingly, I asked selected members of the Hertfordshire Moth Group for their data, which they willingly provided. Collective records for a number of moth traps in Hertfordshire and Middlesex were summarised in graphical form.

A total of 17 people contributed to the data set. This number excludes that from the Rothamsted Insect Survey light traps which operate in the county; because these traps kill all the moths entering them, the numbers obtained are more a measure of recruitment than of total numbers available on a particular night (which must include recaptured individuals). The two types of data should not be combined. The sites contributing data all lie in Hertfordshire and northern Middlesex – the latter away from the maritime influence of the River Thames and untouched by the "heat island effect" that is focused on central London; it is judged that they are all within a sufficiently confined geographical area to be regarded as a single data source. However, only ten of these data sets related to near-nightly trapping at a fixed location; the other seven related to more casual recording. The difference between the two data sets is significant – fixed position traps that are run on a nightly basis also record negatives (nights when none were captured); casual reports do not. Accordingly, only the ten continuous data sets were used in the analysis.

However, it is still necessary to correct the data. For example, if five of the ten were away for the same two school holiday weeks, a dip in the graph line for that period would be evident even though moth numbers were probably high. So, is a graph of the actual results a true reflection of reality or should the graph be corrected in some way? Hertfordshire Moth Group member Emil De Maria, a statistician at the

University of Hertfordshire, willingly took on the task of ascertaining the validity of my analysis. He examined the year 2003 data set and reported as follows:

Records run from 28 May to 8 October – the flight period; during this period there was a high incidence of missing values. Of the 1360 observer-nights (number of observers × nights) during the flight period a total of 361, or 26.7%, lack records because, for whatever reason, one or more traps were not operated on that date. This is likely to have an artificial effect on the line of the flight graph that is not relevant to the real situation. This potential error was dealt with in two ways.

First, the nightly total counts, for all observers, were recalculated (when missing values occurred) on the basis that the missing value was the same as the mean per observer for that night.

Second, it was noted that two observers had high missing values counts 114 and 121 whilst also having low total moth counts 44 and 49 from a grand total of 1081. When the records of these observers are eliminated the missing value percentage drops to 14.6 % but the total moth count is only reduced by 8.6%. The records of these observers were, therefore, withdrawn and imputed missing values were calculated as follows: for nights with missing values a mean value was calculated using the first method above. This mean value was then adjusted for the observer on the basis of that observer's annual total (i.e., for observers with high total the value was inflated and for those with low counts it was deflated). These imputed values were then rounded to the nearest whole number and inserted in place of the missing value. This process yields two time-series of nightly counts:

- a series which uses all the data from ten observers, but has a high missing value percentage
- a series with a lower missing value percentage but has fewer (8) observers.

In order to make a meaningful comparison of these two series the second was scaled up to ten-observer equivalent by multiplying by 1.125.

Next a seven-day moving average was calculated for each series. A moving average will 'smooth out' the day-to-day count fluctuations. Seven was chosen as the length of the moving average because this eliminated any weekly effect due to the observers.

The two series yield very similar results. When correlated the series have a correlation coefficient of .998. The conclusions from this exercise are that there is no statistically significant difference, for this purpose, between the actual plot of data and the corrected data. Therefore, for the data set under discussion the plot of actual data is valid.

The graph of the raw data from the reduced number of 8 traps (all in Hertfordshire) is now presented in Figure 1, with the years 2002 and 2003 shown separately. It is immediately apparent that the graph shows is a clear bimodal pattern characteristic of a double-brooded species. There is also some evidence of a third brood, but the relatively small sample size means that precise interpretation is not possible; a much larger data set is desirable.

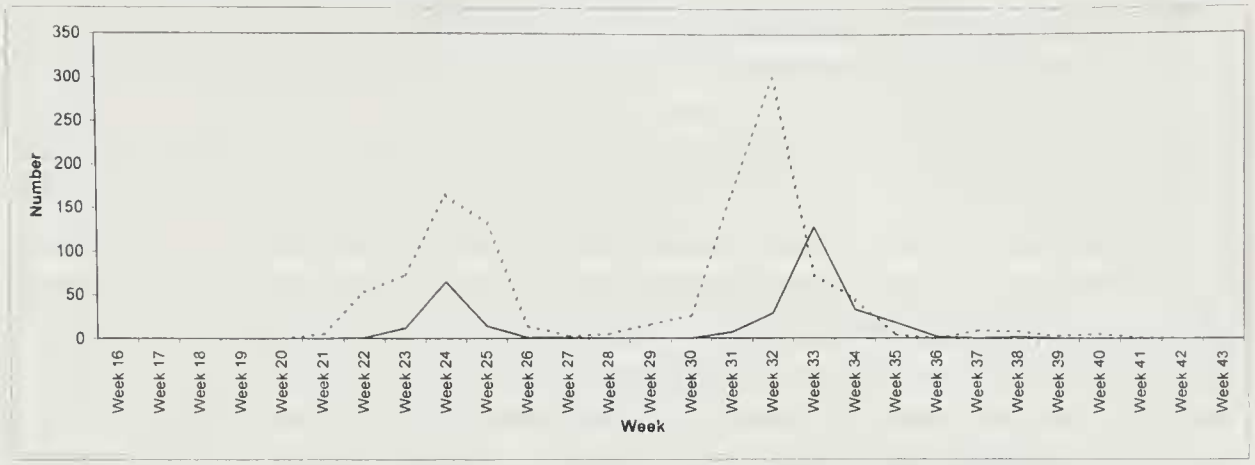

Fig. 1. Numbers of Straw Dot *Rivula sericealis* (Scop.) per standard week, from light traps operated at eight sites in Hertfordshire during the years 2002 (solid line: n=313) and 2003 (dashed line: n=1110). Standard weeks are seven-day units commencing on 1 January; 29 February is included in week 9 and 31 December is included in week 52 (see, e.g., Plant, 1994. *Provisional atlas of lacewings and allied insects of Britain and Ireland*, Biological Records Centre, page 28).

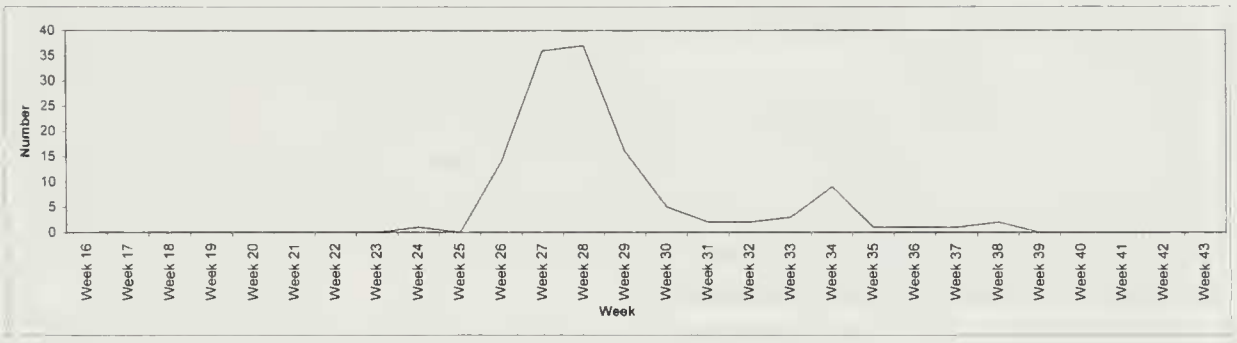

Fig. 2. Actual numbers of Straw Dot *Rivula sericealis* (Scop.) per standard week, from light traps operated at seven sites in Lancashire during the year 2003 (n=136). Information kindly provided by Steve Palmer, Lancashire Moth Recorder. The main population peak falls exactly in the trough between the two Hertfordshire population peaks (week 28).

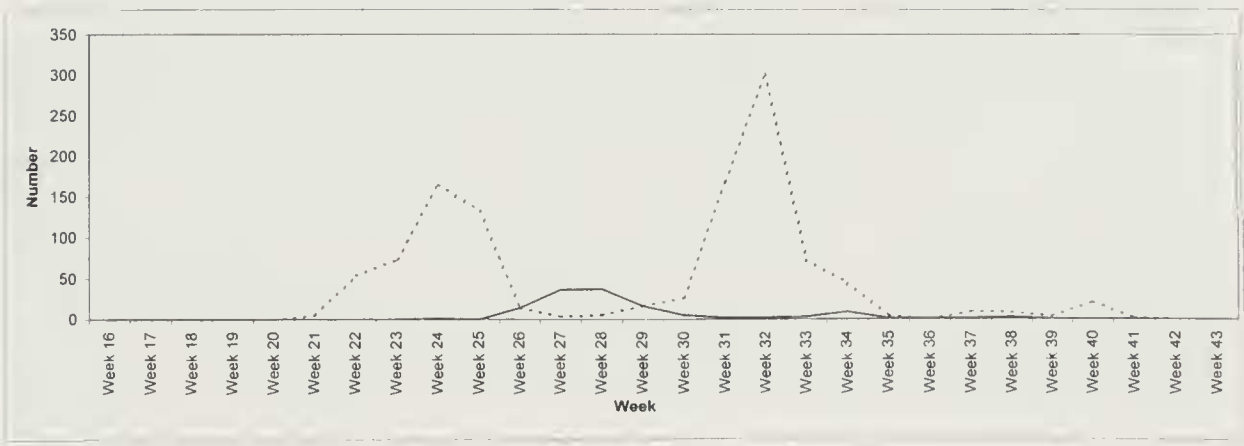

Fig. 3. Actual numbers of Straw Dot *Rivula sericealis* (Scop.) per standard week, from light traps operated at seven sites in Lancashire (solid line) and eight sites in Hertfordshire (dashed line) during the year 2003. There are moths on the wing continuously from week 21 to week 41.

Data for the entire of the British Isles would be sufficient in volume to determine if there is a third brood, but regional variations in voltinism would be masked. In order to demonstrate this, Figure 2 shows year 2003 data kindly provided for the two Lancashire vice-counties by Steve Palmer. There are clearly two main peaks of adults, suggesting a bivoltine habit. However, overlaying this on the 2003 Hertfordshire data (Figure 3) shows that the first peak, which is considerably larger than the second, is a full month later (weeks 27 and 28) than in Hertfordshire and falls precisely in the middle of the trough between the two southern population peaks. The smaller second peak is two weeks behind the southern counties peak for the same year. The Lancashire sample is much smaller (136 in Lancashire, compared to 1110 in Hertfordshire, although it derives from a similar number of traps (seven in Lancashire, eight in Hertfordshire). Nevertheless, combining the year 2003 graph lines for these two areas would produce a line showing a species that is present without a break throughout the summer and which is apparently continuously brooded; analysis of the data on a regional basis shows clearly that this national generalisation is false.

Returning to the Hertfordshire data set, it is evident that Straw Dot adults started to appear two weeks earlier in 2003 (week 20) compared with 2002 (week 22) and continued slightly later (week 40 compared with week 38). In spite of this earlier start, however, the numbers of first brood adults peaked in the same standard week number in both years (Week 24: 11 – 17 June)). However, after the unusually warm and dry summer period, the second brood of adults peaked one full week earlier in 2003 (week 32: 6 – 12 August) than in 2002 (week 33: 13 – 19 August). The reasons for this are unclear, but the shift is real.

My thanks are due to the following Herts Moth Group members who sent me their numerical data for inclusion in this small study: Marcel Ashby, Barnaby Briggs, John Chainey, Jim Fish, Liz Goodyear, Phil Gould, Wendy Hatton, Vincent & Betty Judd, Andrew Middleton, Dave Murray, Bill & Pearl Page, Julian Reeves, Jenny Spence, Rachel Terry and Andrew Wood. I am also gratefully to Steve Palmer (Lancashire Moth Recorder) for the Lancashire data and for his kind permission for me to use it in the comparison. My son Edward set up the computer side of things (apparently something called a macro – I thought they were moths!) to update automatically the graph line as new data was added to the Microsoft Excel spreadsheet. Herts Moth Group member Emil de Maria (University of Hertfordshire) contributed the statistical examination of the data. Peder Skou (Apollo Books, Copenhagen) kindly provided a translation of his published text and Stoyan Beshkov (National Museum of Natural History, Sofia) provided first-hand field data from Bulgaria as well as translation of Cyrillic texts.— COLIN W. PLANT, 14 West Road, Bishop's Stortford, Hertfordshire CM23 3QP (E-mail: colinwplant@ntlworld.com).